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Surgical treatment of chronic atrial fibrillation with conventional electrocautery in mitral valve surgery

Tratamento cirúrgico da fibrilação atrial crônica com eletrocautério convencional em cirurgia valvar mitral

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Abstract

Objective: **To evaluate the results of the surgical treatment of atrial fibrillation for ablation of the posterior wall of the left atrium using electrocautery in mitral valve surgery. Methods: From May 2004 to December 2006, 23 patients underwent surgical correction of mitral valve disease and treatment of atrial fibrillation using the conventional electrocautery for the accomplishment of lines of endocardial ablation in the left atrium. The mean age of the patients was 59 years, and 60.8% were female. The left atrium mean diameter was 50.3 ± 5.09 mm and the left ventricular ejection fraction was 53.6 ± 11.03%.**

Results: **The mean time of extracorporeal circulation was 52.5 ± 13.3 min; aortic clamping, 35.6 ± 12.9 min; atrial ablation, 3.05 ± 0.16 min. All the patients were free of atrial fibrillation after the procedure; on hospital discharge, 69.5%; at 6 months, 91.3%; at 12 months, 76.4%; at 18 months, and at 24 months, 68.4%. At 12 months, left atrium mean diameter was 42.1 ± 3.5 mm; left ventricular ejection fraction was 59.2 ± 3.48%; In addition, left atrial contractility was present in 68.8% of the patients.**

Conclusion: **The surgical treatment of the atrial fibrillation with electrocautery in mitral valve surgery was capable to determine the reversion of this arrhythmia in a significant number of patients during short- and middle-term clinical follow-up without mortality and fewer complications.**

Descriptors: **Atrial fibrillation/surgery. Arrhythmia/surgery. Mitral valve/surgery. Heart valve diseases/surgery. Cardiac surgical procedures. Electrophysiology. Diathermy.**

Resumo

Objetivo: **Avaliar os resultados do tratamento cirúrgico da fibrilação atrial por ablação da parede posterior atrial esquerda utilizando o eletrocautério, em cirurgia valvar mitral.**

Métodos: **De maio de 2004 a dezembro de 2006, 23 pacientes foram submetidos a correção cirúrgica de valvopatia mitral e ao tratamento da fibrilação atrial utilizando o eletrocautério convencional para a realização de linhas de ablação no endocárdio atrial esquerdo. A idade média dos pacientes era de 59 anos, sendo 60,8% do sexo feminino. A média do diâmetro atrial esquerdo era de 50,3 ± 5,09 mm e a fração de ejeção do ventrículo esquerdo de 53,6 ± 11,03%.**

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Resultados: **O tempo médio de circulação extracorpórea foi de 52,5 ± 13,3 min; pinçamento aórtico, 35,6 ± 12,9 min; ablação do endocárdio atrial, 3,05 ± 0,16 min. Todos os pacientes estavam livres de fibrilação atrial após o procedimento; na alta hospitalar, 69,5%; no 6º mês, 91,3%; no 12º mês, 76,4%; no 18º e 24° meses, 68,4%. No 12º mês, a média do diâmetro atrial esquerdo era de 42,1 ± 3,5 mm; a fração de ejeção do ventrículo esquerdo era de 59,2 ± 3,48%; e a contração atrial esquerda estava presente em 68,8% de todos os pacientes.**

Conclusão: **O tratamento cirúrgico da fibrilação atrial com eletrocautério, em cirurgia valvar mitral, foi capaz de determinar a reversão dessa arritmia a um número significativo de pacientes durante um seguimento clínico de curto e médio prazo, sem mortalidade e com baixa morbidade.**

Descritores: **Fibrilação atrial/cirurgia. Arritmia/cirurgia. Valva mitral/cirurgia. Doenças das valvas cardíacas/cirurgia. Procedimentos cirúrgicos cardíacos. Eletrofisiologia. Diatermia.**

INTRODUCTION

Atrial fibrillation (AF) is the most supraventricular arrhythmia related to morbid events (thromboembolic accidents and heart failure), besides increasing mortality in several heart diseases. The Framinghan study [1] has shown that the incidence of stroke is five times higher in patients with AF. The impact in the quality of life, decreased physical capacity and, consequently, decreased labor capacity, complications and sequelae, increased mortality rate in patients with this disease, and increased medical expenses show the importance of its diagnosis and adequate treatment.

With the advances in the understanding of the AF electrophysiology, by means of human and animal pioneer studies, surgical methods were developed aiming at eliminating this arrhythmia.

Surgical treatment became evident from 1991 on, when Cox et al. [2-5] by means of experimental studies and their knowledge of AF electrophysiology published a new technique, the "Labyrinth Operation" (the Maze procedure), described for isolated treatment of FA. This technique consists in multiple incisions and sutures in the atria, forming block lines for the macro-entrant circuits, which are considered to be one of the AF pathophysiological mechanisms [6].

The technique high complexity, increased surgery time, and postoperative complications have stimulated the development of new surgical approaches which were capable of reproducing the results from the Cox's technique less aggressively and with fewer complications.

An alternative proposed in the last few years was the replacement of incisions and sutures by the ablation of atrial tissue with sources of energy (cryoablation, radiofrequency, microwaves, ultrasound, and electrocautery) [7] in order to perform transmural lesions, besides a specific approach of critical areas for AF outburst and perpetuation (ectopic focuses present in the pulmonary vein ostia [8]).

Studies in which the electrocautery was used to perform the ablation lines in the endocardium were successfully in reverting to sinus rhythm, presenting similar results to the Cox's technique, besides reestablishing the left atrium function and significantly reducing its shape size [9-11].

The incidence of AF in patients with mitral valve disease is around 40 to 60%. Jatene et al. [12] confirmed the benefits of the labyrinth operation in patients undergoing mitral valve disease repair. Only 5.3% of the patients undergoing Cox's technique developed atrial fibrillation after 37 months vs. 76.5% of those who underwent valve repair alone.

Some techniques used for AF treatment require long surgical procedure times, increasing the risk and the degree of complications; others require high-complexity and high-cost equipments.

The present research aims at to study the surgical technique of the compartimentalization of the posterior wall of the left atrium by using conventional electrocautery in order to reverting atrial fibrillation in patients undergoing mitral valve disease repair.

METHODS

This prospective study was carried out between May 2004 and December 2006. The study population included 23 patients with ages ranging from 32 to 81 years (59.0 ± 12.79 yrs), 14 (60.8%) were female. The study was approved by the Local Institutional Research and Ethics Committee, and written informed consent was obtained from all the patients.

Inclusion criteria were mitral valve disease with indicative surgical treatment; AF documented for over 6 months (chronic), age > 18 yrs, and left atrium diameter (LAD) > 45 mm. Exclusion criteria were emergent surgery, left ventricle ejection fraction (LVEF) < 35% (Teicholz),

confirmed pregnancy, contraindication for anticoagulant therapy, active infectious endocarditis, another structural heart disease with indicative associated surgical procedure, incapacity or refusal to participate in the study.

Preoperative left atrium diameter ranged from 46 mm to 65 mm (mean 50 ± 5.09 mm). LVEF ranged from 35% to 70% (53.6 ± 11.03%). Etiologically, 9 (39.1%) patients had degenerative mitral valve disease and 14 (60.8%) had rheumatic mitral valve disease. Regarding mitral dysfunction, 9 (39.1%) patients presented insufficiency, 5 (21.7%) stenosis, and 9 (39.1%) double lesion. Two (8.7%) patients were in NYHA functional class II (according to the *Criteria Committee of The New York Heart Association* [13]), 20 (86.9%) in class II, and 1 (4.3%) in class IV.

Operative technique

Longitudinal median sternotomy was used as an access route. After systemic heparinization (4 mg/kg), cannulation of the aorta and the superior and inferior vena cava through right atrium was performed. Perfusions were performed under hypothermia at 27ºC. As myocardial protection, antegrade cold (4°C) crystalloid St. Thomas' Hospital cardioplegic solution over a maximum period of 20 minutes was infused.

After cardiopulmonary bypass (CBP) and aortic cross-clamping were initiated, a longitudinal left atriotomy was performed with direct native valve observation and subvalvar apparatus inspection to confirm repair or replacement requirement.

After mitral valve disease repair, an ablation of the left atrial appendage was performed by sewing its base using a purse-string suture. Then, the compartimentalization of the wall of the left atrium was performed by means of linear ablation of the endocardium with conventional electrocautery.

Two lines of ablation were created around the opening of the pulmonary veins, 5 mm from the margin, in order to avoid cicatricial stenosis of the veins; the right superior pulmonary vein was anastomosed to the right inferior and left superior pulmonary veins, and the left inferior pulmonary vein to the right inferior and left superior pulmonary veins, thus forming a square figure; an ablation line was created in the left atrial "isthmus" interconnecting the line between the left pulmonary veins to the posterior medial portion of the mitral annulus, 5 mm from its margin, to avoid the circumflex branch of the left coronary artery.

The operative field was kept dry during endocardium cauterization by two aspirators. A careful washing of the atrial chamber was performed with slightly wet gauzes before its closure in order to remove the carbonization products to avoid an occasional systemic embolism (Figure 1).

The ablation device consisted of an energy generator of electrocauterization, WEM, model SS-501, manufactured by WEM Equipamentos Eletrônicos Ltda., Ribeirão Preto - SP – Brasil, which was set up to run at 30 watts (cut mode was turned off), and a pen-shaped metal tip used to perform the ablation lines in the atrial endocardium.

At the end of the surgical procedure, the patients were referred to the postoperative cardiac recovery room.

A prophylactic antiarrhythmic drug (amiodarone) was administered. Intravenous administration was initiated with 300 mg after anesthetic induction and kept for every 8 hours during the immediate postoperative period. Then, a 200-mg dose orally once a day for up to 6 months was administered. Oral anticoagulant (fenprocumone or warfarin) from postoperative day 2 on up to 6 months was also administered (except for those with mechanic valve) aiming at to keep prothrombin activity time (PAT) (INR) between 2.5 and 3.5.

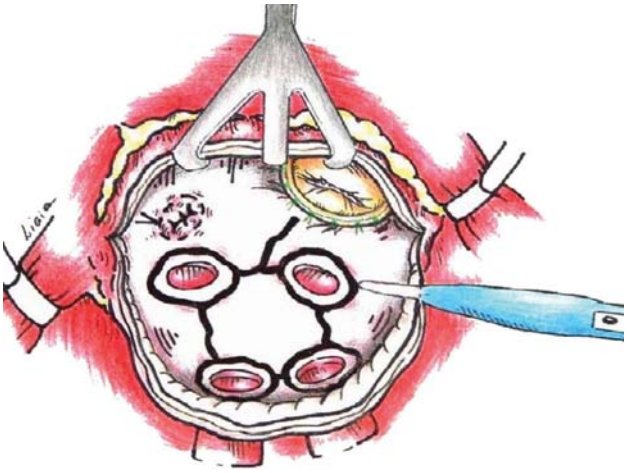

Fig. 1 – Schematic drawing of the ablation lines performed in the left atrium endocardium and the purse-string suture of the atrial appendage base after mitral valve disease repair

Postoperative clinical follow-up

Electrocardiographic/echocardiographic and clinical assessment was performed periodically as follows: in the immediate postoperative period, at discharge, and at 6th, 12th, 18th, and 24th postoperative months. The following variables were assessed: heart rhythm, atrial contractility (mitral Doppler with the presence of an A wave with a velocity > 40 cm/s), left atrium size, LV ejection fraction, NYHA CHF functional class, surgical times (CPB, aortic cross-clamping, endocardium ablation). Cardiologic complementary exams for assessment were electrocardiogram, transthoracic echocardiogram, and 24h-Holter monitoring.

Statistical analysis

Student's *t* test and actuarial curve were used to analyze

the data. A *p* value = 0.05 was considered statistically significant.

RESULTS

Mitral valve repair was performed in nine (39.1%) patients, while mitral valve replacement was required in 14 (60.9%), with biological prosthesis implantation in two (8.7%) and mechanical prosthesis in 12 (52.2%).

The mean CPB time was 52 ± 13.3 minutes and aortic cross-clamping time was 35.6 ± 12.9 minutes. The additional time spent to perform left atrial endocardial ablation was 3.05 ± 0.16 minutes.

After the procedure all patients were free from AF; at hospital discharge, 69.5%; at 6, 12, and 18 and 24 months, 91.3%; 76.4%; 68.4% respectively (Figure 2).

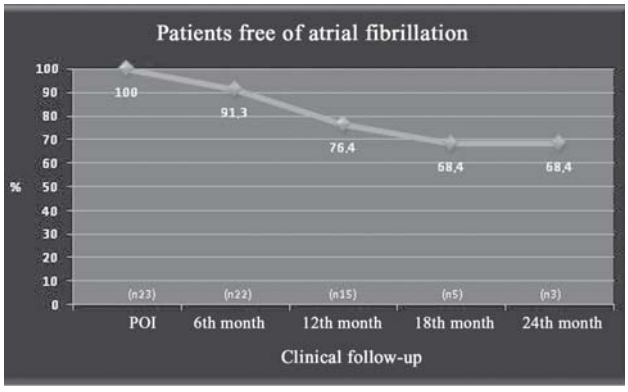

Fig. 2 – Actuarial curve of the patients free of atrial fibrillation after surgical treatment with conventional electrocautery in mitral valve surgery. Hospital Universitário/ UFMS, 2004-2006 (n=23)

Regarding left atrial diameter, at month 6, the mean diameter was 43 ± 3.24 mm; at month 12 and 18 were 42.1 ± 3,5 mm and 41.5 ± 2.26 mm, respectively, and at the end of 24 months, 39 ± 1 mm (Figure 3).

Left ventricle mean ejection fraction was 58 ± 4.36% at month 6; 59.2 ± 3.48% at month 12; 59.5% ± 4.4% at month 18; and 57.7 ± 2.51% at month 24.

At month 12, the mean left atrium diameter was 42.1 ± 3.5 mm; LVEF was 59.2 ± 3.48%; and left atrial contractility was present in 68.8% of the study patients.

Left atrial contractility was present in 73.9% of the patients at month 6. At month 12, 68.81% of the patients presented a net atrial contractility, and at month 18 and 24, it was present in 60.21% (Figure 4).

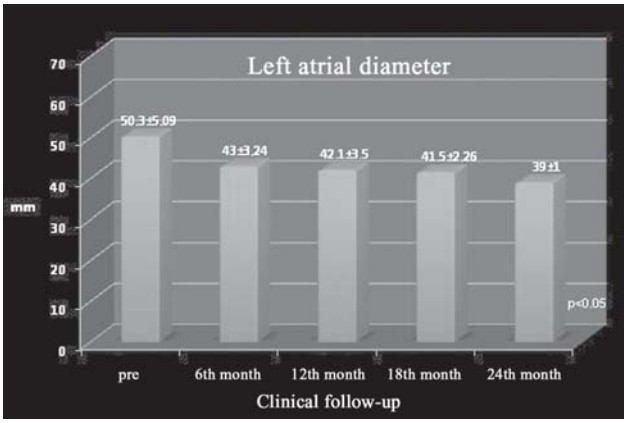

Fig. 3 – Pre- and postoperative left atrial diameter after surgical treatment of atrial fibrillation using conventional electrocautery in mitral valve surgery. Hospital Universitário / UFMS, 2004-2006 (n=23)

Fig. 4 – Actuarial curve of the patients with net left atrial contractility after surgical treatment of atrial fibrillation using conventional electrocautery in mitral valve surgery. Hospital Universitário / UFMS, 2004-2006 (n=23)

One patient has symptomatic bradycardia (low-ventricular response to AF), requiring a definitive pacemaker implantation. There were no cases of postoperative bleeding, or clinical evidence of underlying organ lesion. There were no in-hospital and postoperative follow-up deaths.

DISCUSSION

The AF reversion success rates in this study are compared to those of other authors in a number of variations from the initial technique proposed by Cox et al. [5,12,14,15]. Schuetz et al. [14] undertook a study comparing two groups of patients undergoing mitral valve repair: the first group underwent AF treatment by microwave ablation and the second was the control group. In the treatment group, at 12

months, approximately 80% of the patients were free from AF, while in the other group only 33% of the patients were free from AF. Sie et al. [15] published a study with the use of radiofrequency for AF ablation, in which they followed the lines proposed by Cox's procedure in a biatrial approach, reaching 79% of the regular rhythm at 6 months of clinical follow-up. Abreu Filho et al. [16] published a study with similar characteristics to the abovementioned study, with a success rate of 72.7% patients free of AF at a 12-month follow-up. Brick et al. [17] observed an AF reversion in 88.8% of the cases in the intraoperative period, in a study where the ultrasound was used as an energy source for atrial endocardial ablation.

Sueda et al. [18] addressed only the left atrium for AF treatment and successfully reached 100% of regular rhythm after surgery and 78% at six months. Kalil et al. [19] published a study in which they performed only the isolation of pulmonary vein ostia, reaching 86% of sinus rhythm after a 1-month follow-up. These results were similar to those achieved in the present study, in which only the left atrium was addressed, with 100% of AF reversion after surgery and 77.27% at six months. This may show the importance of the left atrium approach, because it appears to be the most responsible by AF deflagration and maintenance.

Simha et al. [9] showed that using electrocautery to perform biatrial endocardial ablation, 36% of the patients required a definitive pacemaker implantation, probably through biatrial approach. In the current study, in which the approach was restricted only to the left atrium, only nearly 4% of the patients required artificial cardiac stimulation.

Inamdar et al. [10], in an approach only to the left using electrocautery, observed a high rate of AF recurrence in the first months postoperatively, possibly due to inadequate ablation of atrial tissue, producing incomplete lines. Additionally, it was hypothesized that it would be necessary 3 to 6 months to complete cicatrization of the ablation lines to achieve an efficient electrical stimulus block. Recidivation of AF in the first weeks after ablation is evident, not meaning procedure failure. In the current study, just a bit more of 30% of patients were in AF at the hospital discharge; this rate fell by nearly 22% at the third months. This fact can also be explained by the postoperative transient atrial inflammatory process and by the transoperative atrial ischemia [20,21]. Other studies have described ectopic focuses external to the pulmonary veins, or arising from other atrial structures, which would be related to the recidivation of postoperative AF [22,23].

Surgical treatment failure appears to be more associated to predisposing factors, such as patient's age, prolonged AF time, left atrium size, ventricular dysfunction that the employed technique itself [24]. Also, histopathological factors must be considered.

These high rates of AF recidivation justify the use of oral antiarrhythmics and anticoagulants over 3- to 6-month period. Similar protocols were used for several authors [16,25]. There is no consensus about the use of postoperative antiarrhythmics and anticoagulants regarding the time and previous conditions to be withdrawal. In the current study, it was observed a slight increase in the AF recidivation rate after antiarrhythmic withdrawal after 6 months. Maybe it is adequate to establish the sinus rhythm and the atrial contractility before withdrawal the drugs [26].

It could be expected cases of atrial flutter due to not approaching the left atrium, but this arrhythmia was not noticed in the current study. Deneke et al. [25] observed a rate of 12.5% at 3-month clinical follow-up, even being performed a biatrial approach with radiofrequency.

Concerning operative times, the present study showed satisfactory rates in comparison to other techniques for surgical treatment of AF [16,17,27]. In the current study, mean CPB time was 52 minutes and mean aortic cross-clamping time was 35 minutes. Maybe the greatest benefit determined using energy sources is in the reduction or in not significantly prolonging CPB time during mitral valve disease repairs. Atrial endocardial ablation time did not surpass 4 minutes; this fact was probably fundamental to achieve good outcomes, with a low rate of morbidity and no postoperative mortality.

Surgeries for AF treatment can pose inherent complications to the surgical procedure, such as lesion of coronary arteries (circumflex branch), rupture of the atrial wall, and esophageal perfusion (developing atrio-esophageal fistula). They are considered severe but very rare complications [16]. In the current study there no evidences of such complications. There were no re-operations due to surgical bleeding.

Lam et al. [28] demonstrated, at a histological level, the effect of the electrocauterization. Necrosis and extensive rupture of the endocardium were evidenced, besides the underlying myocardial destruction. Despite the good clinical outcomes, there are severe morphological damages in the atrial tissue. In the same study, it was evident that the power setting and the tissue contact time exert a direct effect on in the depth of atrial lesions. At a power setting lower than 25 watts, the destruction is low, making it impossible to create atrial lesions. At a power setting higher than 45 watts, there is a predisposition to atrial perforation; over 35 watts also increases the proportion of having coagulated tissue. Thus, the best outcomes with high necrosis of tissue coagulation and lower perforation risk would be using a power setting between 30 to 35 watts and tissue contact time ranging from 1 to 3 s/cm. Lower power settings would not generate sufficient damages and higher power settings would cause damages to the surrounding structures and atrial perforation. The authors concluded that electrocauterization does not

determine transmural lesions histologically. However, the excellent clinical outcomes raise a doubt regarding the need of transmurality as a prerequisite to electrical isolation.

Left atrial appendage is responsible for up to 90% of the embolic strokes, and its excision, or exclusion, determines the reduction for thromboembolism risk, even without ablation of the left atrium [29,30]. Changes in the atrial natriuretic hormone could be reduced by not removing the atrial appendages, thus avoiding postoperative fluid to build up [9].

The extensive pathogenesis variation, symptomatology, and patients' profile are factors hampering the development of global recommendations for a standard treatment of AF, but surgical ablation seems to play an increasing role for several reasons: high success rate, surgeons' direct view making the ablation safer and faster, the removal of left atrial appendage reduces the risks for thromboembolism, and the simplicity of the technique, which does not prolong surgery times, make it possible to be performed by every surgeon.

CONCLUSION

The present study showed that the surgical treatment of atrial fibrillation with electrocautery, in mitral valve surgery, was capable of determining the reversion of this arrhythmia in a significant number of patients during a short- and long-term clinical follow-up, without mortality and with low morbidity. Moreover, it is a fast-reproducing surgical approach, reducing CPB time, and accessible, with no need of special and expensive equipments.

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